THE AËRONAUTICAL JOURNAL.

APRIL, 1907.

The Aëronautical Journal.

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NOTICES

OF

The Aëronautical Society of Great Britain.

At a meeting of the Council of the Aëronautical Society of Great Britain, held at the Society of Arts, John Street, Adelphi, on Thursday, March 7th, 1907, the following gentlemen were elected members of the Society:

- MR. ANTHONY C. BARNES.
- MR. GEORGE W. HART.
- CAPTAIN H. R. HAYTER, A.S.C.
- MR. LIONEL JAMES.
- MR. ALBERT JAMES MCKINNEY, M.A.
- MR. W. COOPER MATHEWS.
- COLONEL SIR WYNDHAM MURRAY, C.B.
- MR. ANTOINE MUTTI.
- MR. TAGE GEORGE NYBORG.
- MR. OLIVER PRYCE.
- MR. GEORGE PERCY DEVERALL-SAUL.
- MR. FREDERICK RICHARD SIMMS.

THE LIBRARY.

The following publications have been presented to the Library:—

By MAJOR B. BADEN-POWELL.
- "Travels in the Air" (Glaisher).
- "The Aërial World" (Hartwig).
- Old Prints, various.

By COLONEL J. D. FULLERTON.
- "Recent Progress in Aërial Navigation" (Lecture by Colonel J. D. Fullerton).

By the METEOROLOGICAL OFFICE.
- Publications of the International Aëronautical Commission, 1905.

By the St. LOUIS AERO-CLUB.
- Aëronautic Map of St. Louis.

By MR. F. H. BUTLER.
- "500 Miles in a Balloon" (F. H. Butler).

KITE DISPLAY.

It has been arranged to hold a Kite Display on Chobham Common, Sunningdale, Berks (by kind permission of the Earl of Onslow), on the occasion of the summer meeting of the Aëronautical Society of Great Britain in July next, the exact date of which will be duly announced. Members and others who may wish to display kites at this meeting are requested to communicate with the Honorary Secretary of the Aëronautical Society of Great Britain, 53, Victoria Street, Westminster, London, S.W., as soon as possible.

To members there will be no entrance fee for this display, but to non-members there will be an entrance fee of five shillings for the privilege of displaying their kites on the ground acquired by the Council of the Aëronautical Society of Great Britain.

All kites displayed will have to be approved by the Council of the Aëronautical Society of Great Britain.

Amongst those who have already promised to display kites on this occasion are Mr. Charles J. P. Cave, Mr. S. H. R. Salmon, and Mr. Reginald Mansfield Balston.

In addition to the display of kites, arrangements have been made for Mr. José Weiss to give an outdoor exhibition of gliding models, and some other features of aëronautical interest will be added, details of which will be announced later.

THE MILAN EXHIBITION.

The Honorary Secretary of the Aëronautical Society of Great Britain has received official notice from the British Commission of the Milan Exhibition that a silver medal has been awarded the Society for its loan exhibit at the Milan Exhibition.

It has further been announced that bronze medals have been awarded to the following gentlemen who participated in the loan exhibit:—

Mr. Charles Brogden.

Mr. S. H. R. Salmon, M.Aër.Soc.

Messrs. Newton and Co.

THE FORTHCOMING TRAVEL EXHIBITION.

There will be an aëronautical section in the forthcoming Travel Exhibition to be held at the Royal Horticultural Hall, Westminster, May 18th to June 8th next. There will be a loan exhibit of photographs, prints, and diagrams of aëronautical interest, contributed by the Aëronautical Society of Great Britain.

The management have expressed their willingness to place free space at the disposal of members of the Aëronautical Society of Great Britain who may wish to exhibit models or other objects of aëronautical interest. Those who may wish to take advantage of this offer are requested to communicate with Mr. A. Staines Manders, organising manager of the Travel Exhibition, 75, Chancery Lane, London, W.C.

ANNUAL SUBSCRIPTIONS.

The annual subscriptions to the Aëronautical Society of Great Britain became due on January 1st. Those members who have not yet paid their annual subscriptions are requested to forward them to the Honorary Secretary, 53, Victoria Street, Westminster, London, S.W. The attention of those members is called to Rule IV.a, which states that the privileges of members extend only to those who have paid their subscriptions for the current year.

ERIC STUART BRUCE,
Honorary Secretary.

GENERAL MEETING.

The second meeting of the forty-second session of the Aëronautical Society of Great Britain was held at the Society of Arts, John Street, Adelphi, on Thursday, March 7th, 1907. The President, Major B. Baden-Powell, occupied the chair.

The Honorary Secretary read the minutes of the last meeting.

Wings v. Screws.

By COLONEL J. D. FULLERTON, R.E.

1.—The subject I propose to bring before you to-night, viz., the comparative merits of wings and screws for purposes of propulsion, etc., is one of considerable interest, and I hope that members who have studied it will give us the results of their investigations in the discussion following the reading of the paper.

2.—Statement of the Problem.

Briefly the subject for discussion may be defined as follows:—Given a flying machine of the general type shown in Fig. 1, which is the best form of lifting and propelling apparatus, the marine screw type, or the movable wing type propeller, giving both lift and propulsion.

3—Necessity for Carefully Analysing Both Types.

In order to arrive at a satisfactory solution of the problem, it is necessary to carefully examine the action of each type, and to ascertain as far as possible how the power supplied by the motor is expended. In the following paragraphs, therefore, an attempt will be made to analyse both systems and to compare their efficiencies.

4.—Machine Fitted With Marine Screw. (Figs. 2, 3, 4.)

Commencing with the Marine Screw type (see Fig. 2), one sees that this class consists of two quite distinct parts, viz., the aërosurface a a, or lifting apparatus, and the screw *b* for providing the driving thrust T.

When the screw is in action, the air supplies a force A, the vertical component of

Wings v Screws.

Fig. 1.

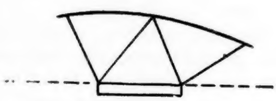


Fig. 2.

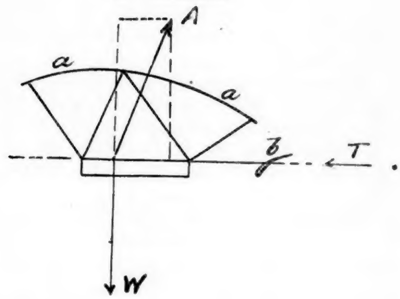


Fig. 3.

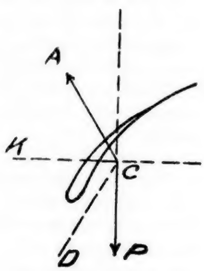


Fig. 4.

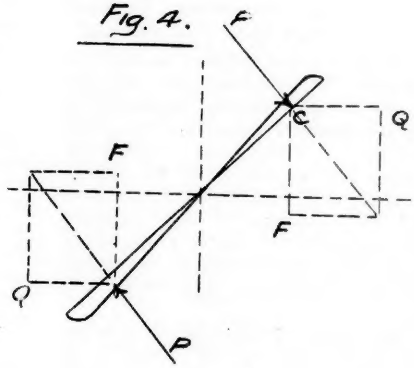


Fig. 5.

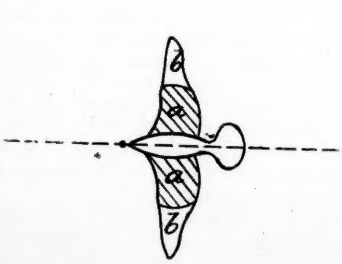
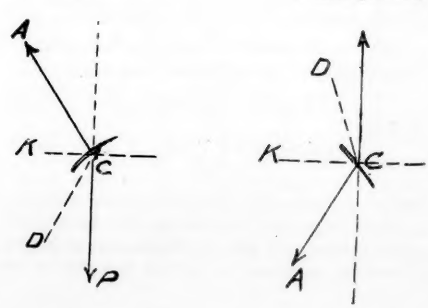


Fig 6

Down stroke Up stroke



which equals the weight of the whole machine W, while the horizontal component is the resistance which the thrust T has to overcome.

As regards the action of the propeller, I have already discussed the subject in a paper published in the Journal of the Society in 1897, and shall not, therefore, go into a detailed account of its motion, but, speaking generally, the action is as explained below (see Fig. 3).

When the turning force P is applied, an air force A is generated, the result being that the centre of pressure of the blade C is forced along the C D, while the whole machine is driven along C K by the thrust T.

The efficiency of the propeller is:—

$$= \frac{\text{useful work done,}}{\text{total work done,}}$$

$$= \frac{T \times \text{distance machine advances,}}{P \times \text{circumference of circle traced by } C \times \text{revolutions.}}$$

The efficiency of the ordinary marine type of propeller is about 60 per cent., but this figure can be considerably improved by making the blades similar in form to the wings of the fast flying birds. Such wing-like shapes are, as can easily be seen by testing them in a whirling table, far more effective than the kind of blade generally used in marine screws, and a propeller designed on these lines should be just as efficient as the wing form upon which it is based.

The next point to consider is, how the total work provided by the motor is expended. Fig. 4 shows an end view, or elevation of the propeller. P is the turning force, and it is clear that the air is driven in two directions, viz., outwards along C O and downwards along C F (varied in a corresponding manner in the other sectors of the circle). Let the velocity of rotation = V, then:—

Work done in driving air outwards.

$$= P \sin L \times V, \sin L = P V, \sin {}^2 L$$

Work done in driving air downwards, etc.

$$= P \cos L \times V, \cos L = P V \text{ cost } {}^2 L,$$

hence

$$\text{total work} = P V, \sin {}^2 L - P V, \cos {}^2 L$$
$$= P V,$$

which agrees with the value given above.

It is important to realise that a considerable amount of air is driven outwards and inwards, as, when the action of wings is examined, it will be seen that they waste part of the power applied to them in exactly the same way.

As regards the important question of safety, the marine screw type appears to be much better than any other, as in the event of the failure of the motor, the whole machine simply slides down to the ground along a slope, its weight being taken by the fixed aërosurface.

5.—Moveable Wing Type Machine.
(See Figs. 5, 6.)

In discussing this type we are at a great disadvantage, as it is extremely difficult to say how the birds, which are the best example of this class of machine, really use their wings. A good deal of information on the subject is given by Mons. Marey in his book, "Le Vol des Oiseaux," but a glance at the photographs taken by him (every $\frac{1}{100}$ second) will show how complicated the movements of the wings are, and how difficult it is to calculate the power expended from the action of the wings.

As regards theories of wing action, the two most important appear to be the "Aërosurface," propounded by Sir George Cayley, Mr. Wenham, and Mons. Marey, and the "Screw," advocated by Mr. Pettigrew and others.

In the "Aërosurface" the wings are divided (see Fig. 5) into two parts, the passive a a, and the active *b b*. The passive portion a a, sustains the bird just as the aërosurface a a in Fig. 2 does; its movements in a vertical direction are small, and it may, in fact, be considered as a stationary surface fixed at the most favourable angle for lifting.

The active portion *b b*, is considered to be a reciprocating screw propeller, the blades of which can, owing to their flexibility, vary their form (see Fig. 6) to suit the up and down strokes. The thrust to drive the machine along is obviously obtained on the down stroke, but it is not quite clear that this is the case in the up stroke. It really depends upon whether the bird uses its muscles to pull the wing up; probably in full flight the muscles are slackened off, thus allowing the wing to be lifted by the pressure of the air underneath it, while at the commencement of flight, when great power is required, the muscles do work, and thus produce a thrust in the upward as well as in the downward stroke.

In the "Screw Theory" the wings are considered to be screws, the flexible blades of which have a reciprocating instead of a rotatory motion. Owing to the constantly varying form and angle of inclination of the wings it is almost impossible to say what the pitch of the screws at any given moment really is, and, consequently, accurate calculation of the effect produced is extremely difficult. But there is no doubt that the centres of pressure of the wings do trace out screw-like curves, and that if sufficient data were available, the lift and thrust at any moment could be quite well calculated from the usual screw propeller formula given in my paper of 1897.

It should be noticed that in this class of machine air is driven outwards (or inwards) as already explained when discussing the marine screw type.

As regards safety, I think the movable wing type is not a very satisfactory one, as if by any chance the motor stops when the wings are nearly at either their highest or lowest position, a disaster is very likely to occur.

6.—Concluding Remarks.

The whole question may be summed up as follows:—

1.—There is little or no difference as regards efficiency between the two forms of propellers. If a really good shape of blade is used in a marine type screw, there is no reason why it should not be just as efficient as the corresponding wing type.

2.—The marine screw type appears to be the safest, as if the motor accidentally stops, the safety of the whole machine is not endangered.

The **President**: I will ask Major Moore, who has given considerable attention to the subject of wings, and who has brought some models to show us, to say a few words on the subject of Colonel Fullerton's paper.

Major **Moore**: I think an ounce of practice is worth a great deal more than a pound of theory, and these models, I think, show practically that wings are very efficient. As regards the danger of the wings going up, there is no necessity of their going above the horizontal, so they would act like a parachute. In this design I do not allow them to go beyond the horizontal, as long as they give a sufficient amplitude. The flying fox is the type I followed. I studied these animals thoroughly, had them tame in cages, and these models have been made exactly in imitation of them. The first model I made weighed and was in size in every respect as much as possible like a flying fox, and when I set it going, it ran away flapping its wings like a fowl trying to fly, and that encouraged me to go on. In this design I have introduced a spring to represent the pectoral muscle, which absorbs the power of the up stroke, and doubles the power of the down stroke. (Model with clock springs shown.) What I want to show is that the wings have a driving force. The wings, however, ought to be flatter than in these models. By calculating out the power required, these wings ought to be able to fly 100 lbs. per h.p., but practically it would be safe to allow 50 lbs. per h.p. I think wings are much more efficient than screws. We want the maximum of efficiency with the minimum of weight, and I believe this form gives that.

Dr. **Hutchinson**: I might take exception to two of the points of view of the lecturer which I remember. The first is, he says that with regard to screws and wings, if you have air escaping with the velocity, that is waste. It may be, to some extent, but inasmuch as it has had a velocity given it, there has been a reaction to that velocity, and so it has not been wasted. With reference to his contention that wings might be dangerous, inasmuch as, if the motive power broke down, the tips of the wings would meet in the air and there would be less parachute area, I do not think that is a strong argument against the use of wings, because if the engine stops, you can easily guard against diminution of parachute area by having a pectoral cord. In the Frost-Hutchinson machine we have this. The pectoral cord would prevent the wings rising in the air and meeting at their tips. I contend that wings constructed on the bird model are more efficient than screws, from any data that I am aware of, and I would advocate a flying machine constructed of that kind of wings, but with a fixed parachute area. You can arrange the parachute area on the same plane as the wings. With regard to the resistances of screws, in the Frost-Hutchinson machine we have with no more than 3 h.p., and under unfavourable circumstances, obtained a thrust of 160 lbs., with a total wing area of 60 square feet. I understand those results are superior to any that have been obtained with screws. If I am correct, the bird's wing type is one which is promising. There is a point which has not been animadverted upon by the lecturer, namely, owing to the construction of primary feathers energy is stored, and you do not get a true reciprocal motion, because at the down stroke energy is stored in the feathers, and some of it may be given out during the up stroke. There are several points in a wing-flattened machine, namely, you must have a pectoral cord to store up energy on the up stroke, and you must have primary feathers to store up energy on the down stroke, and those primary feathers automatically exert a swing. Another argument which occurs to me in favour of wings is that on each stroke you get a positive lift. With a screw machine, apparently, you must obtain a minimum velocity of 20 miles an hour before you get much of a lift. It appears to me that the bird's wing type, whether you use it as a fixed aëroplane or a reciprocating wing, is the type to adopt, because we know that it works, and we know why it works.

Colonel Capper: I do not know that the thrust of 160 lbs. mentioned by Dr. Hutchinson has ever been reached by a screw propeller.

The President: Mr. Walker's experiments got a lift up to about 40 lbs. This is one of those papers which it is well to bring before the Society. I take this opportunity of saying that I made some experiments lately with lifting propellers, which I think it is worth mentioning to the Society, because although the results were negative, it may save others making an experiment which does not come off successfully. My idea was to make a machine on what is called the helicoptère principle. I had two screw propellers on vertical shafts of a certain type, and when these revolved the machine was lifted up. The inner halves of two semi-circular paddle-box screens were arranged around the inner sides, so as to cause the outer blades of the screws to propel horizontally, and I hoped to get the result that these screws, whilst rotating, would lift and propel the machine along. In order to increase the propulsive effect, I increased the pitch of the screws, till the blades were nearly vertical, but as I increased the pitch I decreased the lift, and with a fine pitch there was no propulsive effect. So I soon found it was impossible to combine the two effects with the same propellers.

Colonel Fullerton: Perhaps I did not make myself understood as to what I meant by waste of power. When the bird drops its wings down part of the air is driven outwards. That is wasted; it does not drive the bird along or lift it. Whether the amount of amplitude of wing-beat given by Major Moore is sufficient it is impossible to say, but it is obvious that the birds at all events raise their wings considerably above the level position. As regards the shape of propeller blades, they should be on the wing pattern. Regarding the starting question, you have to run along at 20 miles an hour. A bird does that; he either jumps into the air or he runs along the ground and gets up his velocity that way. The thrust of 160 lbs. seems very large. Certainly propellers would not do that. Was all the thrust given straight backwards?

Dr. Hutchinson: No. The bird was hung by a spring balance from a tree, and the wings flapped. The bird jumped about; every time the wings went down the whole thing went up into the air. The point I was laying stress upon was a thrust roughly at right angles to the direction of motion of the moving part, whether you take it at right angles to the plane of the wing, or parallel to the axis of the propeller.

Colonel Fullerton: I was using the word thrust in the ordinary sense, viz., as the force produced by the air, driven directly to the rear. The force at right angles to the direction of motion is the lift.

The President: It now remains for me to propose a vote of thanks to Colonel Fullerton for his interesting paper.

The Free Lever in the Flying Machine.

By CHARLES MILLA.

The Working of Forces in the Flying Machine.

When a flying machine is going through the air in a horizontal direction, there are *four* forces to be taken into consideration. They are explained by the figure 1, which represents a section through the wings FcG and the trunk RS, this section being made in the direction of the flying.

Q is the total weight of the machine; the direction of this force is perpendicular, its working-point g.

M is the resultant of the pressure of the wind against the *wings*. This force works in the point c, and its direction is generally slanting from below to above and backwards, so that it forms an angle with the lead; this angle may be called "angle of action" (β).

W_2 is the resistance of the air against the trunk; this force works backwards in the direction of the axis of the trunk; its working-point may be thought at pleasure, perhaps in d.

P, the impulsive power of an engine, which is supposed to overcome the existing resistances; this force has its working-point in a, and works forward in the direction RS.

The weight Q is known.

The resistance of the wind is

$$M = b_1 \frac{\gamma}{g} F_1 v^2 \quad .. \quad .. \quad (1)$$

In this formula b_1 is a co-efficient that has been determined by Lilienthal with 0,546, if $\beta = 3^\circ$; γ is the specific gravity of air; g=g,81 (acceleration of gravity), therefore $\frac{\gamma}{g} = 0,13$; F_1 is the surface of the wings, measured in square metres; v the velocity, measured in metres.

The perpendicular lift is: $a = M \cos \beta$ (2) and the drift of the wings: $W_f = M \sin \beta$ (3)

The common working-point of M and Q is in h (Fig. 1); they form the angle 180°— β.

From these measurable forces can be drawn the resultant force W=hk, and it is:

$$W = \sqrt{Q^2 + M^2 - 2QM\cos\beta} \quad .. \quad .. \quad .. (4)$$

Henceforward:

$$W_r = b_2 \frac{\gamma}{g} F_2 v^2 \quad .. \quad .. \quad .. (5)$$

In this formula b_2 is another co-efficient than b_1; ($b_2 = \frac{1}{?}$); F_2 the highest rate of cross-section of the trunk.

P—W_r have their working-point in a, but W in h, and between these two points, there is, consequently, a piece of the solid frame of the trunk; this piece of the frame can be considered as a lever, and has, therefore, been called "free lever." The engine being in the air, and therefore "free." In the figure the straight line ah is this free lever.

Now, the constant dimensions of the engine are as follows:

ζ = ab, distance of the power P from the cross-section F_2;

σ = cb, distance of the working-point c from the trunk-centre b,

$\tau = cg_0$ distance between c and a, parallel to the axis of the trunk; that is, $g_4\ g_8$. In the latter the centre of gravity can have several positions, so that

$\omega = g_0 g$ is the distance of this centre of gravity from the cross-section F. ω has been called "mass-distance." Then we have:

$$H = \sqrt{(\zeta - \omega)^2 + (\omega \cot g\,\beta - \sigma)^2} \quad .. \quad .. \quad (6)$$

We can also determine the position of the free lever as respects to the ship and as respects to the lead. But it is enough to conceive from the diagram that, with this arrangement of forces, the flying ship will be forced to incline down-forward. But, if it shall go on farther in a horizontal direction, then must be:

$$M = \frac{Q}{\cos}\beta$$

and consequently:

$$W = Q\,tg\beta \quad .. \quad .. \quad .. \quad (7)$$

in consequence of the equation (4)

Then it is also:

$$W = W_f \text{ and } P = W_f + W_r \quad .. \quad .. \quad (8)$$

Finally the mass-distance

$$\omega = \sigma\,tg\beta \quad .. \quad .. \quad .. \quad (9)$$

This equation is of the highest importance. It says: In case of the equilibrium, the centre of gravity of the flying ship must have a fully determined position, and this position is dependent of the depth which is given to it (σ), and of the angle between the resultant power M and the lead, that is of β.

With that also is declared, on the contrary, a fixed position of the centre of gravity only permits a fully determined inclination of the wings (α).

If the inclination of the wings changes, the angle β also changes, and with β also ω, and with that the dimensions and the position of the free lever. But these circumstances finally cause the raising or sinking of the ship, or its remaining in the same level.

If another quantity of the equation (9) changes, this also alters the other one, and with great sensibility.

Consequences.

From these manifestations evidently follows, that the conversation of the equilibrium, as well as the *steering*, is possible *without a helm*, only by changing the proportion between the centre of gravity and the direction of the resistance of the air. Accordingly to equation (9), $\omega = \sigma tg\beta$.

It will suffice to give to ω (mass-distance) that value as it follows from the equation (9) for a certain value of β. This demand is the same as if the bicyclist with his wheels, running both in *one* straight line, or the skater upon the small edge of his

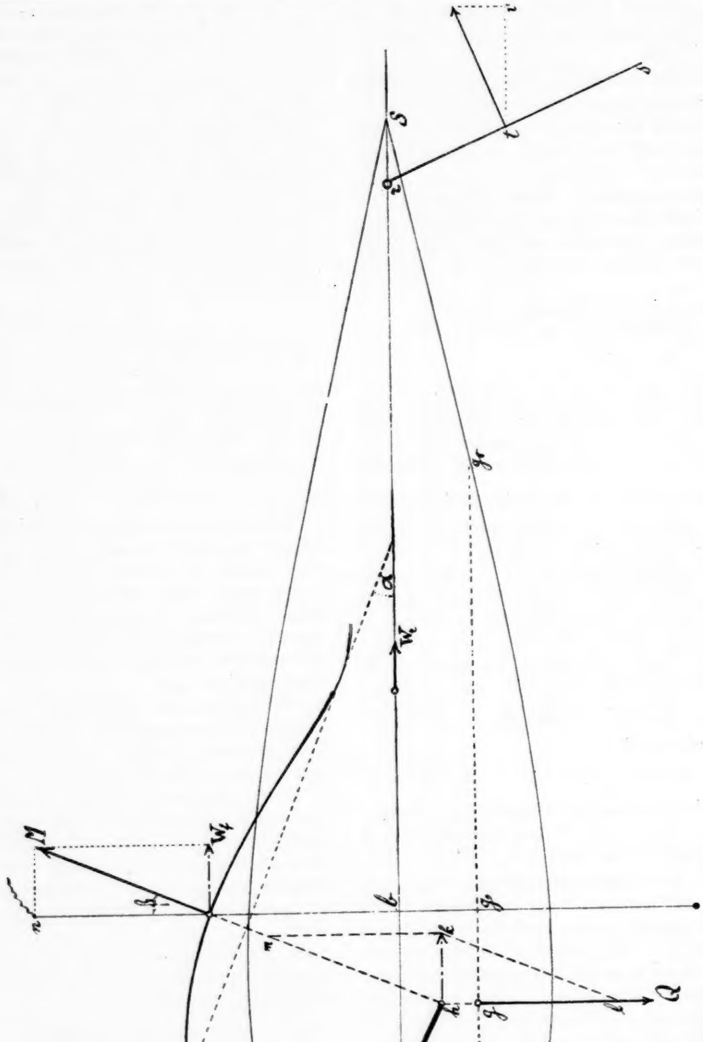


Fig. 1.

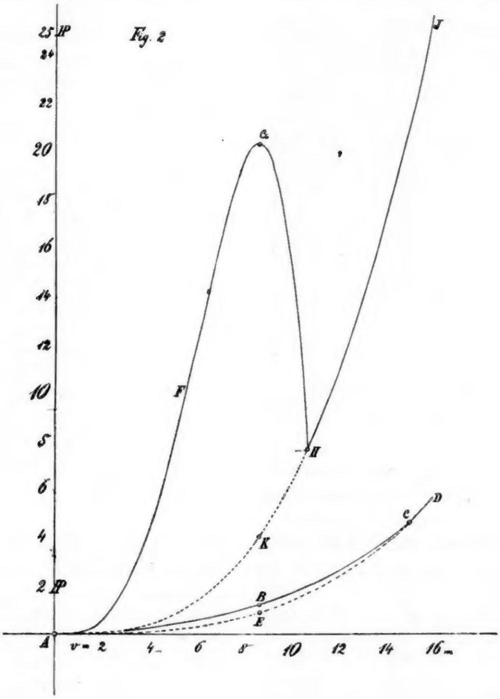
skates, will remain in his way with tranquillity and security. And to be sure, the precise adjustment into a certain proportion must be much easier with the flying ship than with the bicycle or the skate. For the first is in midst of the supporting air, and the centre of gravity (g) is always *deeper* than the point of suspension (c), whilst, on the contrary, with the vehicles upon a fast ground, all these circumstances always are more unfavourable referring to a danger of a sudden and violent fall.

justment of the centre of gravity (value ω) and of the working-angle β, the expense of working-power can be reduced to its minimum.

Advantage 4.—The security of the flying is warranted to the last degree.

Advantage 5.—The start from the ground can be performed with a minimum of working-power.

Advantage 6.—The stopping for landing can be performed completely and with the full security of the voyager.



Moreover, the steering of the flying ship by means of adjustment of the centre of gravity and the inclination of the wings (or by "adaptiveness," as I will call it) offers many most valuable advantages. These are:

Advantage 1.—The working-power, inevitably connected with the appliance of a helm, can be spared.

Advantage 2.—The excess of weight of a steer likewise can be spared, and the arrangement of the flying ship, therefore, will be more simple.

Advantage 3.—By means of subtile adjustment

Advantage 7.—By this means of adaptiveness, the wheeling about (steering sidewards) is also to be performed easily and safely.

DEMONSTRATIONS.

Advantage 1.—Is rs in the diagram 1, a helm in its usual form, its resistance tu with its component tv will always be a continual impediment. For, at the construction of a flying ship with a fixed centre of gravity (system fixed), it is impossible to fix the centre of gravity immediately on the right place in the ship without mentioning that the accommodation to other circumstances (steering) always demands the incidence of the impeding helm. At the determination of the working-power necessary for flying, especially for lasting flying, this impeding surface of the helm can by no means be neglected.

Advantage 3.—If A_g signifies the total working-power for lasting flying in horizontal direction, regarding the equations (1), (3), (5), it will be:

$$A_g = \left\{ b_1 \frac{\gamma}{g} F_1 v^2 \sin\beta + b_2 \frac{\gamma}{g} F_2 v^2 \right\} v \quad .. \quad (10)$$

This working-power (mechanical effect) is only dependent on the working-angle β, if we suppose that Q (equation 7) and v (velocity of the flying) always are invariable. But this angle β most essentially depends on the nature of the wings, whether it is vaulted or plain, elastic or inflexible, and it is sure that individual peculiarities of the bulk will play a decisive part, and can only be taken in consideration if, during the voyage, it is possible to give to the wings the most subtile adjustment.

This most subtile adjustment causes the intended minimum value of the angle β, and with that the minimum value of the mechanical effect A_g.

From that now follows the necessity to endow the ship with adaptiveness at the outset.

Advantage 4.—If this arrangement permits a quick and sure accommodation to changed circumstances (as, of course, we suppose), this arrangement also will be the warranty for exact steering and avoiding of dangers caused by gusts and that kind of thing.

Advantage 5.—If, at starting, the ship is borne by fast ground and not by the air, the angle β will be very small, the resistance of the wings $= \theta$, and the whole mechanical energy can be used only for a very quick run. In this case we also employ the adaptiveness of the ship.

Advantage 6.—On the contrary, at landing, very much impediment shall be produced, in order to annihilate the existing mechanical-power as soon as possible. This can be done by enlarging the angle β that is, enlarging the inclination α of the wings. Then, by proportional displacing of the centre of gravity, the mass-distance ω always will accommodate itself to the value of β, and, therefore, the horizontal position of the flying ship will be kept.

The "landing-way" s, which is still made after the stopping of the engine, until the impediments have annihilated the whole mechanical energy of the flying mass, is:

$$s = \frac{l_n v_a}{a} \quad .. \quad .. \quad .. \quad (11)$$

if v_a signifies the velocity of the ship in the moment of stopping, and a the constant value:

$$a = (b_1 F_1 \sin\beta + b_2 F_2) \frac{\gamma}{Q} \quad .. \quad .. \quad (12)$$

In this case it is possible to enlarge the value of β, and if the ship has adaptiveness, the value of s will diminish in the same measure as β and a increase.

[The proof of the correctness of equation (11) cannot be given here for want of space. But it is to be found in the author's book: "The Free Lever in the Flying Machine," which will be published soon.]

Advantage 7.—If the left wing of the ship receives a larger inclination than the right one, it also endures a larger drift than the latter, and, therefore, will remain behind a little. In this case the ship will turn to the left.

SOME SPECIAL RESULTS OF CALCULATING FOR A FLYING MACHINE OF 200 kg = Q AND BY A VELOCITY v = 15 m.

β	ω cm	M kg	W_f kg	W_r kg	P kg	A_g HP	S m
3°	$4,_{5}$	$200,_{28}$	$10,_{48}$	$12,_{53}$	$23,_{01}$	4,6	$539,_{7}$
51° 3′	$118,_{6}$	$340,_{79}$	275_{86}	,,	$288,_{4}$	57_{7}	$71,_{12}$

For the Start.

If the start of the flying ship is made by means of wheels on a good road (not on rails), the mechanical energy is produced by the equation:

$$A'_g = (c_1 + c_2 - c_4) v^3 + c_3 v \quad .. \quad .. \quad (13)$$

Hereby is:

$$\left.\begin{aligned} c_1 &= b_1 \frac{\gamma}{g} F_1 \sin\beta, \\ c_2 &= b_2 \frac{\gamma}{g} F_2, \\ c_3 &= n\,Q, \\ c_4 &= n\,b_1 \frac{\gamma}{g} F_1 \cos\beta \end{aligned}\right\} \quad .. \quad .. \quad .. \quad (14)$$

n signifies a new value; that is, the coefficient of friction in the motion of a carriage on good road, where there is $n = \frac{1}{50}$.

But if the start is made by means of a boat swimming upon a water-surface (as, for instance, Mr. Kress intended at Vienna), of course, there a larger working-power will be necessary, which is to be calculated as follows:

$$A''_g = (c_1 + c_2 + c_5)\, v^3 - c_6\, v^5 \quad .. \quad (15)$$

Hereby is:

$$c_5 = b_3 \frac{\gamma'}{g} \frac{Q}{L}, \quad c_6 = b_3 \frac{\gamma'}{g} \frac{b_1\, \gamma/g\, F_1 \cos\beta}{L} \quad \ldots \quad (16)$$

b_3 is a co-efficient for the calculation of the resistance of the ship in water, γ' the weight of a cubic metre water, and L the length of the swimming boat.

[The proofs for these equations are also to be found in the author's detailed book.]

With these equations some special values have been calculated and then construed the curves of the diagram (Fig. 2).

The curve ABC of this diagram shows us the increase of the necessary working-power (at running "on good road") with the increase of the velocity v, until the velocity of 15 m causes the raising into the air. This maximum velocity demands a mechanical energy of 4,6 h.p.

The curve AEC allows us to compare the exigencies of energy, for it shows us the but little slower increase of the energy in the case that the friction of ground is abstracted from.

If we calculate the resistance of the water against a boat, the exigence of working-power at the start, already at the velocity of 8,6 m, mounts to 20,34 h.p. (represented by the point G of the curve AFGH). Without the resistance of the water, this exigence for the same velocity would only be 4 h.p. (Point K of the inferior incurvation AKH.)

However, if the velocity v increases, the lift of the air-resistance (α) increases too; the boat, being more and more heaved out from the water, will offer less and less hindering surface to it; the resistance of the water decreases and becomes of little or no importance compared to the increasing air-resistance.

Therefore, the curve representing the working-power rapidly falls from G to H. At a velocity of 10.7 m, the water-resistance fully disappears; then the air-resistance is strong enough to bear alone the flying ship. Now begins the free flying, and the mechanical energy increases according to the law, expressed in equation (10) and represented by the curve in its way from H to I. Therefore, to make fly one single man, Mr. Kress wants 21.06 h.p. by a speed of 15 m.

The total result of my demonstrations may be expressed as follows:—

The flying machine must be endowed with "adaptiveness"; that is to say, it must have a regulation (arrangement) so that it may be possible to displace the centre of gravity, as well as to change the inclination of the wings. This arrangement not only permits a secure steering of the ship towards all sides (without a special helm), but also warrants the minimum exigence of working-power for flying. Even by this "adaptiveness" the start from plain road as well as landing (stopping) can be easily and safely performed.

Colonel Fullerton: On the last page of the paper, is the power (nearly 5 h.p.) carrying a weight of 200 kg.? This seems very high. That is at the rate of something like 80 lbs. per h.p., and the best thing that has been done as yet is not over 50. It is very difficult to say anything about a complicated paper like this, but it is very interesting, and it goes into the question of amount of power required, which is important.

Colonel Cody: As regards the lift h.p. We have a much greater lift in the Wright Brothers' machine—6-12 h.p. was used, and lifted 900 lbs.

Colonel Fullerton: I believe it is 24 h.p.

M. José Weiss: There must be a distinction between weight h.p. and weight that is lifted. In the Santos-Dumont machine there was a thrust of about 7 lbs., but, nevertheless, he lifted his whole machine, which weighed about 600 lbs. So that you cannot compare the thrust, which is the actual produce in force of your engine, to what you get out of your aëroplane, because you have to add the power obtained from your weight, which adds to the speed.

The President: I think this is a paper which requires a certain amount of study. I have not been able to follow it all, because its calculations require carefully going into. We must be very much obliged to Herr Milla for coming over specially to read this paper, and it is evidently one of considerable value. I will, therefore, ask you to accord a hearty vote of thanks to Herr Milla.

The vote of thanks was carried with acclamation.

The Theory of Sailing Flight.

By JOSÉ WEISS.

Whenever a thinking man begins to consider the question of flight, he is struck by that mysterious paradox of Nature, the perpetual movement witnessed in the flight of sailing birds, and on examining the various explanations of the phenomena brought forward from time to time, one must confess that none of them can be said to be anything like satisfactory. I will mention only the explanation proposed by the much-regretted Prof. Langley in his famous work on the "Internal Work of the Wind," but only to ask if, with all our admiration for Langley's able and patient work, we are not bound to acknowledge that the even and undisturbed course of smoke, of clouds, or of a balloon, testify to the even and undisturbed course of the great masses of air and to the total absence of any variations of speed or pulsations whatsoever from which mechanical energy might be derived? I submit that Langley's mistake lies in the fact that he places the pulsations recorded by his instruments in the wind itself, whereas, in fact, these pulsations are produced by the encountering of resistance; that is, by the instrument itself. Air, like water, cannot be touched without a wave being instantly set up. Have you ever seen a flag or similar object exposed to the wind that did not wave?—and we can gather an idea of the mechanical energy of air waves from the fact that they will tear a flag into rags, and that even such minute ones as the sound waves are strong enough to impress the hard substance of a phonograph cylinder.

I have been experimenting with models of gliders on and off ever since I was a boy, but it is especially since Lilienthal's unfortunate death that I have taken this up as a regular hobby, and in these past five years alone I reckon that I have constructed no less than some 200 of these models. The thousands of launchings made with these models have led me to the discovery of a factor, the existence of which I can prove experimentally, and it is that factor, as I will endeavour to show you, that lies at the very root of the problem.

In all my reading on this favourite subject I have never come across any suggestion that the reaction which takes place in sailing flight could be due to anything else but air pressure. It is this very point which is misunderstood. I mean to say, that there exists a mistaken conception about the nature of the reaction which really takes place.

Let me quote a short example which will explain better what I mean by the "nature" of a reaction. We can press a nail into a piece of wood by means of a hammer, but not without great exertion. By striking the nail with the hammer we can drive it home with hardly any exertion at all. In both methods there is a reaction of the hammer on the nail, but in each case the reaction is different in its nature and in its properties.

My contention is that the reaction which obtains in sailing flight is *not* a reaction of pressure; that reaction is a vibrative one; that is to say, that by the impact with the air of the bent down front edge of the wing a wave is set up under the wing, and it is the action or the beating of that wave on the under surface of the wing which produces the sustentation or lift. And the properties of that energetic wavy reaction are different to the properties of a reaction due to ordinary air pressure.

The properties of the reaction due to air pressure are known with certainty from secular experience. They are mainly threefold.

In the first place, the reaction due to air pressure is proportional to surface.

In the second place, its intensity varies as the square of the speed.

In the third place, in the case of a plane striking the air at an angle, the reaction is proportional to the sine of the angle which the position of the plane makes with the line of flight, commonly called the angle of incidence.

I am in a position to show experimentally, by means of experiments made with actual free gliders, and of such a nature that they leave no room whatever for doubt, that:—

Firstly, in free sailing flight, at equal speed, the reaction is *not* proportional to surface, but varies as the power four-thirds of the surface. I had observed some years ago that in birds of similar shape the relation of weight to surface followed that ratio.

In a pamphlet published in September, 1904, M. Goupil relates that he has observed the same fact with birds, but draws no conclusion from it. Had M. Goupil been in possession of a type of glider sufficiently perfect to obtain from it accurate data, and had he made experiments with models of graduated sizes, he would have found, as I have found myself, that at equal speed the relation of weight to surface in artificial free gliders is exactly the same thing as in birds. I can assure you that the experiments by which I can prove this point are very striking and quite conclusive.

Secondly, whereas we know that reactions due to air pressure always vary as the square of the speed, I can show by experiments equally conclusive that in free sailing flight the reaction does *not* vary as the square of the speed, but is directly proportional to it, neither more nor less.

And last, but not least, whereas we cannot conceive a reaction due to air pressure unless there be at least a slight incidence, I can prove experimentally that not only in free flight no incidence whatever is required, but that the position in which the maximum of that vigorous reaction is obtained is when the main portion of the wing is dead parallel with its line of flight, and you will observe that in this position, the front edge being bent downwards, the chord drawn from the front to the rear edge is actually at a negative angle with the line of flight. It will be remembered that Lilienthal also revealed the existence of a reaction at a slight negative incidence. I cannot enter to-night into the details of the experiments, nor do I expect that my statements will be accepted unreservedly, since they are in direct contradiction with all the accepted formulas and theories, but if an opportunity can be arranged at some large empty hall, where I could use models up to 20 or 30 lbs. of weight, I am willing at some future date to show the truth of my statements in the presence of experts. To see is to believe; when you have seen the experiments you will know, as I know myself, that these things are not a matter of opinion, but that they are hard facts from which it is impossible to get away.

Let us now see what is the bearing of these facts upon that vexed problem of the motionless sailing flight of birds.

In our attempts to figure out the sailing flight of birds, the greatest stumbling block is "incidence," because incidence cannot exist without creating resistance, and involves, therefore, the exertion of some power to overcome that resistance, and we know that the sailing bird develops none. But if the lift can be obtained without incidence, as I can prove it to be the case, then the problem immediately takes a different aspect.

If a dead bird with its wings outstretched in the correct flying attitude be exposed well straight to however strong a current of air it will be found that the resistance offered is absolutely nil. This may seem paradoxical and impossible. It is, nevertheless, an undeniable fact. To account for it we must bear in mind two things. The first one is that for some unaccountable reason a curved surface, such as the upper part of the front edge of the wing, not only offers no resistance, but actually produces a sort of suction. Lilienthal had already found this to be the case, and it is also very easily ascertained experimentally. The second point to bear in mind is that from the mere fact of its construction, the wing of a bird produces a forward horizontal component, because the front edge being bent down and rigid, and the rear edge being tapering and yielding, the supporting air must tend to escape from behind, and in doing so, sends the bird forward.

If we now consider that the lifting reaction is produced by speed only, and that the resistance to penetration is nil, it becomes evident that as soon as the bird begins to glide, the speed, and, consequently, the lifting reaction, must increase as long as the line of flight is a descending one, until the mean direction, which in this case is the horizontal, is reached, and this, theoretically, is nothing short of the perpetual movement which we observe in the sailing flight of birds. One might object that the production of the sustaining wave must absorb a certain amount of power and cause a corresponding amount of resistance; this is obviously so. But we must bear in mind that the whole of the weight is acting as motive power, and that with a perfect wing and the absence of all resistance and friction, that weight must naturally produce a reaction equal to itself.

I think I can safely challenge anyone to figure out from the "incidence" theory even such results as I have obtained from my own models. I have in some cases, in dead calm air, obtained glides within 3° of the horizontal; that is, with a drop of one in about twenty. Such successful glides cannot, however, be obtained at will with unguided models, as they depend upon an accuracy of conditions which can only result from a living balance. But the mere fact of having obtained them once proves conclusively that the feat is possible as soon as all the necessary conditions are present.

The question of flight is not one of great power; it is proved by the motionless flight of the larger birds. It is entirely one of perfect shape and material; of perfect relation of weight to surface; of perfect adjustment of centre of weight; of perfect amount of rigidity and elasticity in relation to weight; and last, but not least, it is a question of necessary reflex movements on the part of the operator to counteract instantaneously any disturbing effect from outside causes. But all these conditions can be conquered; it is only a matter of dogged perseverance, of time and of money. I firmly believe in the advent of a flying machine within the price of a bicycle, with no other power required than that which a man can develop by means of pedals unaided by machinery.

To the practical man all I have said will appear somewhat of an abstract nature. The reason of this is that the men who take an active interest in this burning question of aviation are of two classes: There are those who offer prizes, and there are those who hope to win them. I belong to the latter, and it is not my intention, therefore, to assist rivals with practical hints. But the theoretical facts which I have just laid before you are bound to be rediscovered and confirmed before long, and by stating them in public I may as well secure for myself the honour of having been first in bringing them to light.

Before the reading of this paper the author exhibited several models of gliders which made several successful flights in the room.

After the reading of the paper he made the following additional remarks on the subject of

Longitudinal Balance.

I think I may speak with authority on the matter of longitudinal balance, because with my gliders I have obtained results which no man has obtained before. For instance, I have this model, which I made for this occasion, but it would be dangerous to show it in this room, as it is too fast. In order to make this model fly in the wind I have to put on this weight, which brings the weight up to ½ lb. I launched it yesterday, and the results were so extraordinary that I hardly expect to be believed; I do not know that I should believe in them if I had not seen them myself. There was a N.E. wind blowing at the rate of about 20 miles; I had favourable circumstances, and I launched it twenty times. Once it stood for 40 seconds quite motionless. It was launched on the ground, rose to 30 or 40 feet, did not turn, did not lose its height, and remained hovering like a hawk or kestrel. It is a positive fact. With regard to the weight, if I weighted this model with this weight, the speed will be 10.50m. per second (illustrating). Now, in order to make this model, which is larger, go at exactly the same rate, viz., 10.50m. per second, I have to weight it up with 15 lbs. of lead. If I weight it like this, it will travel at the same rate. When I put the large weight on this model, which has a surface of 27 square feet, and weighs 11 lbs., the total weight becomes 26 lbs. This one has a surface of 1.37 square feet; when it is weighted for 10.50m. speed it will carry not even as much as ½ lb. per square foot, and will travel at the same speed. If that is not a proof that the reaction is not proportionate to the surface I give it up. The theory of longitudinal balance is this. If I hang this model level it remains so. What is the reason of that? It is because the support is in concordance with the centre of weight. If I move the support only a quarter of an inch below, the thing goes forward, so that we can say with certainty that the only cause that can make an aëroplane keep horizontal is when the two centres of pressure and gravity are in concordance, and inversely when we see a glider keep the horizontal position, it is because the two centres of pressure and of gravity are in mathematical concordance. If you start from this fact, what causes them to remain in concordance? We know all the difficulty of longitudinal balance arises from the mobility of the centre of pressure, and when we see a glider keep its balance, we conclude the two centres are in concordance. The reason is, to my mind, that the movements of the centre of pressure, although very nimble, are not erratic; they follow the speed. If your speed alters, your centre of pressure shifts. On the other hand, if the movements of your centre of pressure are not erratic, the speed also is not erratic. In the same way as the length of a pendulum determines the beat of the pendulum, so in a glider there are certain factors which determine its speed. If, therefore, we know those factors, we can calculate the speed, and if we also know what are the movements of pressure in relation to that speed, we can calculate where the centre of pressure will move at that particular speed. The law is this: That the centre of weight has to be at the point which the centre of pressure reaches at the normal speed. Your glider cannot possibly, then, lose its balance, because it tends to its normal speed, whatever wind it may be in. I am talking of its relative speed, of the speed as compared with the surrounding air. As soon as it goes back to that speed, the centre of pressure moves back into the centre of gravity, and the glider rights itself. You cannot upset it. From my tower, which stands 42 feet from the ground, I can throw my model anywhere, and it will right itself. I am in possession of the formula of speed and the movements of the centre of pressure. These formulæ are based on my experiments. Supposing I constructed a model like the large one which I constructed for the exhibition at the Agricultural Hall, the 15 lbs. weight gives me a speed of 10.50m., and I must have between the normal centre of pressure and centre of gravity so many millimetres.

Colonel Cody: Our friend, in his paper, has misconstrued the Brothers Wright in dipping their wing. His idea is not new, it is an old idea, and I have worked on it ever since I have been an instructor, so that it is not original.

M. José Weiss: I simply claim this, that there is the specification of the Brothers Wright at the Patent Office, and it claims in order to turn to the right the incidence on the left has to be increased—as a matter of fact, it is the reverse that has to be done.

The President: I think that we have heard really one of the most interesting papers which we have had here for some time. It has put matters before us which we ought to study. I have always found there is something mysterious about the way in which these little gliders go, because they do not seem to go according to known laws. I do not believe the whole action is caused by the pressure on the under surface; there is a great deal of suction above. Mr. Weiss has brought forward matters of very great importance. I will ask you to accord your vote of thanks to Mr. Weiss for his interesting paper, and I only hope that he will be able to come again later on to show us some more experiments.

A vote of thanks to the Chairman for presiding was proposed by Colonel Fullerton and seconded by the Secretary on behalf of Colonel Capper, who had been obliged to leave early.

The proceedings then terminated.

Reviews.

The Pocket Book of Aëronautics. By Major Hermann W. L. Moedebeck. Translated by W. Mansergh Varley, B.A., D.Sc. London, Whittaker and Co.

The English translation of the "Pocket Book of Aëronautics" will be welcomed alike by the theoretical student, the practical balloonist, and the new army of workers in aëroplane construction. Entirely comprehensive it does not pretend to be. A full treatise on the subject no pocket book could contain. It is, notwithstanding, almost a miracle of compression, containing a fund of useful and exact knowledge. It is impossible to be just and to give it anything but unstinted praise.

It is without doubt the best book that has yet appeared on the subject in the English language, a welcome contrast to some recently published popular volumes, the perusal of which leaves the reader as ignorant of any exact knowledge as he was before the book was opened. The "Pocket Book of Aëronautics" should be in the hands of every aspirant after solid aëronautical knowledge, while it should be the constant companion of the matured worker.

The plan and arrangement of the little volume is admirable. The general excellence of its information has been, no doubt, secured by the method of entrusting the authorship of the various sections to experts in the particular subjects treated. Each section, therefore, becomes specialistic, a result that is not so apparent when a work throughout is under one authorship.

At the commencement of the work we find several chapters devoted to those physical principles upon which practical ballooning depends. The compilation of those chapters will save the student many a weary search through ordinary physical text books and encyclopædias, as he will find the knowledge he wants to apply ready to hand. The physical properties of gases, the technology of gases, the physics of the atmosphere are discussed in a clear, precise, and ample manner. In the chapter on the technology of gases, considerable space is devoted to the methods for producing hydrogen, including the electrolytic process, concerning which not much has hitherto been published. As an example of the useful knowledge imparted under this heading of the electrolytic process, we learn that sixty hours will be required to fill a balloon of 600 cubic metres capacity.

Chapter III., which deals with meteorological observations in balloons, is one which will be extremely useful to those who aspire to make scientific balloon ascents, and the sample tables given for the guidance of those who take observations should be noted. Such lucid instructions for observing atmospherical phenomena in balloons should tend to increase the number of scientific observers in balloons, which, in spite of the increasing desire for balloon travel, shows lamentable scarcity.

Then comes a chapter by Major W. L.

Moedebeck, on the "Technique of Ballooning," in which are treated in masterly fashion materials, varnishes, strength of balloon envelope, the fibrines, the use of metals and wood, the cutting out of the material, the tailor work, manufacture of balloons from gold beater's skin, balloon valves, tearing arrangements, the rope maker's work, the basket maker's work, landing arrangements, anchors, trail ropes and floats, steering arrangements, captive balloons, kite balloons, sounding balloons, etc. Amongst useful tables in this chapter are those dealing with the breaking strain of Italian hemp ropes, the tensile strength of different metals per sq. mm., and the calculated breaking stresses of steel cables with an internal hemp core; also a table for the use of rubber balloons.

Chapter V. is devoted to kites and parachutes. This goes very fully into the details of modern kite flying. The history of the kite is not neglected, and due mention is made of the work of Mr. Douglas Archibald, who, in 1883, revived scientific kite flying, and that of Major Baden-Powell, who first used kites to lift men from the ground.

Chapter VI., on Ballooning, is one that will be of extreme use to the yearly increasing number of amateur balloonists who have discovered that the balloon has been for long a neglected means of travel and sport, and who wish to be rapidly instructed in the fascinating art of balloon manipulation. This section is divided into two portions, the first of which deals with the theoretical principles of ballooning, the second with the practice of ballooning. In this latter portion will be found invaluable instructions on the inflation, weighing and letting go, the voyage, and landing. Equally welcome to the amateur balloonist will be Chapter VII., on Balloon Photography, while the more serious class of aëronauts will find in Chapter VIII. abundant information on the important subject of photographic surveying from balloons. Chapter IX., on Military Ballooning, deals with the doings of the various Government balloon organisations. This section has been made thoroughly up-to-date, and includes notes on the use of balloons by the Russians and Japanese in the recent war.

The subject of firing at balloons both by hand weapons and cannon is also treated in this chapter, as is the use of the airship in war. This question is one being much discussed at the present moment, and Major Moedebeck's remarks concerning the probable utility of airships will be read with interest.

As regards the military airship as a weapon, he says: "The increasing difficulty of directing artillery fire at an enemy who is in position at a great distance away is one of the problems which will be solved by the development of the military airship.

"In a manner analogous to the action of the torpedo in naval warfare, the heavy artillery of the field army will be reinforced as regards destructive power by air torpedoes directed from the airship.

"A war waged in this manner will be more humane than one as at present conducted, since in this case only the destruction of the means of resistance of the enemy will be aimed at, whereas in shooting over long distances useless destruction of another nature is wrought, and is indeed quite unavoidable (*e.g.*, destruction of the library and theatre during the siege of Strassburg, 1870-71).

"The means of destruction to be cast from the airship will include the strongest explosive bomb materials and poisonous gases, which will render the positions in the regions under fire untenable by man, and render the food and forage which is affected unusable. Against other airships and balloons quite light flares can be made use of, designed to act only after they have been thrown.

"The transport of such fighting material, technically considered from an aëronautical standpoint, is only possible in very small quantities."

In Chapter XI. the subject of animal flight is briefly sketched. The next chapter treats of artificial flight, and contains articles by Otto Lilienthal and M. Octave Chanute. In the latter article will be found a description of the earlier gliding experiments of the Brothers Wright, illustrated by some excellent photographs of their machine taken by M. Chanute. Reference is also made to their more recent experiments, the exact details of which have been withheld by the experimenters.

In this article will be also found information about the work of Captain F. Ferber, M. E. Archdeacon, M. E. Esnault Pelterie, and J. J. Montgomery, whose work has hitherto not been very well known in this country.

Chapter XII. deals with airships, and the well-known constructions of Zeppelin, Santos Dumont, Severo, Bradsky, and Lebaudy are tersely described and well illustrated.

Following on these descriptions are points to be noted in building airships, such as the motor, the propeller, the independent velocity, the diameter of the airship, the shape and size of the balloon, the calculation of the dimension, the construction of spherical cones, the maintenance of the shape, the stability, the shape of the framework, etc.

Excellent chapters on flying machines, motors, and airscrews, by Major Hermann Hoernes follow, and the concluding chapter is devoted to the aëronautical societies of the world, in which due mention is made of the fact that the oldest society is the one of which this journal is the organ.

A number of useful tables and formulæ form the appendix to this capital little volume.

NOTES.

The Exploration of the Air.—Major Baden-Powell recently gave an address before the Royal Meteorological Society on the "Exploration of the Air." He observed that the atmosphere was as yet little explored. We crawled about the ground like crabs at the bottom of the sea, and made our meteorological observations down on the ground in ignorance of nearly all that was going on in the expanse of air. The exploration of the air attracted the attention of two classes of persons—meteorologists, who wanted to find out the science of the weather, and inventors, who would utilise the atmosphere as a highway of travel. Man now possessed three means of aërial exploration—balloons, kites, and flying machines. The balloon was a cumbrous and delicate apparatus, and the limitations to its practical use were now being realised. It had, however, been found useful as an observatory for scientific investigations, as a means of reconnaissance in war, and as an agreeable way of spending an hour or two.

Recently the navigable character of the balloon had been vastly improved. Twenty-five years ago the French Government made the first dirigible airship, and now they possessed some that seemed to be really practical air vessels of war. Count Zeppelin had also produced in Germany a machine which in point of size, as well as speed, had beaten all records.

Major Baden-Powell referred to the work of *ballon-sondes* in exploring heights which could not be reached by living observers, and mentioned that these small balloons with self-recording instruments had recently ascended to the enormous altitude of 82,000 feet. Meteorological kites had ascended up to a height of four miles. Man-lifting kites were now introduced into the military service at Aldershot, but Major Baden-Powell remarked that men were first lifted by this means in 1895, and he himself made a number of ascents up to 100 feet high.

It was stated that modern improvements in kite construction had enabled men at Aldershot to be lifted 3,000 feet, an elevation practically beyond the reach of rifle bullets, and where the observers were invisible.

Passing to flying machines, Major Baden-Powell quoted the words of Sir Hiram Maxim: "The flying machine has come to stay." In the past it had been predicted that it would be impossible to lift into the air what was heavier than air, but the advocates of human flight pointed to the birds, and there was no gainsaying the thing was possible. Then it was argued that a flying machine could not be balanced, because in them the intelligence of the bird was absent, but models had been made to fly for three-quarters of a mile. Men had also taken to gliding on wings and sailing on the wind. Huge machines were constructed with very light engines, and not only had men of late raised themselves from the ground, but they had sustained themselves for half an hour at a time.

The Accident to M. Santos Dumont's New Aëroplane. — M. Santos Dumont's experiments with his aëroplane No. 2 have not proved as successful as those he tried last year with his No. 1. In fact, the new structure is already a wreck, and nothing remains of it except the motor. In the No. 2 the lifting surfaces of the upper and lower aëroplanes were made of thin mahogany and there was no canvas in the structure. Thus, did the *Morning Post* of March 22nd describe the apparatus: "The machine has the appearance of a gigantic dragon fly, with two wings and a tail-piece constructed of open sections of thin walnut wood, looking like cigar boxes with the top and bottom knocked out, and very fragile, seeming to the touch as though violent contact with anything bigger than a sparrow would entail a fracture. In the dip between the wings is placed a motor, and immediately beneath is the aëronaut's seat, fashioned exactly like that of a reaping machine, but with springs underneath. The framework of the machine is partly of steel and partly of bamboo, and underneath the seat is a small thick-tyred wheel which serves to carry the machine along its preliminary run." The result of the trials certainly bear out the criticisms of fragility. To many minds the substitution of wood for canvas will have seemed to be not a change for the better.

The Aeroplane Experiments of the late Professor Langley.—The *Daily Graphic* lately called attention to an obituary notice of the late Professor Samuel Pierpoint Langley, which was read before the Philosophical Society of Washington by Mr. Cyrus Adler. "Mr. Adler says there can be no doubt that Mr. Langley's failure to launch his giant machine in 1903 came as a serious blow. Not so much the failure itself, for he was a philosopher and a scientific man, who knew that success could be reached only after repeated defeat. Had it meant unsuccessful experiments in his laboratory or shop it would have daunted him not in the least. But it was necessary to make the trials in the open air, before the eyes of the world, while his arrangements with the Board of Ordnance and Fortifications rendered it imperative that the details of the construction should not be made public. The newspaper Press of America, misunderstanding his motives, and angered possibly at the large expense connected with maintaining special correspondents at an inconvenient place on the Potomac River, united in a chorus of ridicule and attack, which in time made itself felt in the national Legislature. Langley was then nearly seventy years of age, and the attitude assumed by the public Press broke his spirit at this, the first, indeed the only, defeat in his career. One or more private individuals offered him the means to continue, but he would accept nothnig when coupled with commercial conditions, declaring that the work was solely in the interests of the nation, and if the nation was not prepared to support it he was not willing to proceed with it. Aërial navigation was in his opinion sure to come, and the very machine which was declared by the public Press to have been wrecked beyond hope he had repaired in absolute condition for another experiment."

But though Langley has passed away, not so will his work. Had he lived till the present year his despondency would have ceased. As Mr. Adler further pointed out, the principles which Langley discovered are now gaining recognition, and the aëroplane of the future will be based upon the models which he made and flew.

The International Balloon Races in St. Louis in 1907.—The following are the prizes for the International Balloon Races in St. Louis this year:—

1st prize: The Gordon Bennett Cup.

2nd prize: 1,000 dollars offered by Mr. Adolphus Busch.

3rd prize: 750 dollars offered by the United Street Railways Company of St. Louis.

4th prize: 500 dollars offered by the Nugent and Bro. Dry Goods Company.

5th prize: 250 dollars offered by the St. Louis *Times*.

With regard to these competitions, the St. Louis Aëro Club has issued a map in which is shown the principal balloon voyages which have taken place from St. Louis. The longest of these was the famous balloon journey made by John Wise, in his balloon "The Atlantic." The following details of the journey are given on the map:—

"The balloon started at 6.40 p.m., Friday, July 1st, 1859, and landed at Henderson, N.Y., at 2.20 p.m., July 2nd, having covered 1,150 miles. The route included Pana, Ill.; Fort Wayne, Ind.; Fremont, Sandusky, and Fairport, Ohio; Dunville, Ontario, and Niagara Falls. The balloon contained 60,000 cubic feet of gas and 900 lbs. of ballast. Professor Wise was accompanied by John La Mountain, of Troy, N.Y.; D. A. Gager, of Bennington, Vt.; and William Hyde, of St. Louis. The landing was made in a sycamore tree, 20 feet above ground, in a driving wind, which whipped the balloon to shreds."

On the Aëronautical map is also a note concerning the St. Louis winds and temperature. "In October, in which month the balloon races will occur, the prevailing winds are from the south and south-west, and have an average velocity of 10 1-10th miles per hour. Observations of the cloud movements by Edward H. Bowie, of the United States Weather Bureau, who is also a charter member of the Aëro Club of St. Louis, show a prevailing movement of the upper air currents from the south-west and west, and at a much higher velocity than the surface currents have. It would be impossible for a balloon to go west from St. Louis any considerable distance unless it be a dirigible balloon; for as soon as it rises to a height of a mile or so above the earth it will be carried in an easterly direction. The average temperature for October at St. Louis is sixty degrees Fahrenheit."

The Trials of the Delagrange Aëroplane.—On March 17th a flight of 50 yards was made by the Delagrange aëroplane. M. Voisin was making experiments with the aëroplane on the Pelouse at Bagatelle, his object being to test the stability and equilibrium of the aëroplane without any design at attempting real flights; but at a certain moment M. Voisin was tempted to let the machine go, and she went up gracefully in the air for some fifty yards. While writing this note the news has come to hand that M. Delagrange's aëroplane on March 31st exceeded the above-mentioned distance, and rising to a height of four yards covered a distance of 160 yards.

Applications for Patents.

(Made in January, February, and March.)

The following list of Applications for Patents connected with Aëronautics has been specially compiled for the Aëronautcal Journal by Messrs. Bromhead & Co., Patent Agents, 33, Cannon Street, London, E.C.

JANUARY.

16. January 1st. M. Kay. Improvements in Flying Machines.

266. January 4th. J. G. Batchelor. Improvements in or relating to Aëronautical Apparatus.

313. January 5th. A. Ellis. Improvements in Machines Propelled through the Air, and Travelling along Aërial Supporting Ways or the Like.

368 January 7th. W. J. Frame. Improvements in "Heavier than Air" Flying Machines.

388. January 7th. A. J. Watts. Aëro-marine Vessel.

396. January 7th. A. Guadagnini. Improvements in Flying Machines of the Aëroplane type.

841. January 12th. A. Haste. Improvements in and to driving and lifting mechanism for Aëroplanes, Airships and the like.

861. January 12th. J. B. Johnston. Improvements in or Connected with Aërial Machines,

1004. January 15th. G. Wallace. Improved Flying Machine.

1391. January 23rd. B. H. Wallin. Improvements in Wings for Flying Machines.

1392. January 23rd. R. Waugh. Improvements in Apparatus for Aërial Navigation.

1809. January 24th. W. Rose Smith. Improvements in Apparatus for Flying.

1960. January 25th. G. L. Davidson. Improvements in Flying Machines.

1965. January 25th. W. Wingate. Improvements in Mechanism for Propelling Boats, Balloons, Airships, and the like.

2084. January 28th. W. E. Burgess. Machine for and Method of Travelling Through the Air, Independently of a Balloon or the Earth.

2137. January 28th. P. J. Esser. Improvements in Flying Machines.

2186. January 29th. J. STODDART. Improvements in the Construction of Flying Machines.

2217. January 29th. D. L. MOORHEAD. Improvements in Aëroplanes.

2342. January 30th. G. E. WADE. Improvements in and Relating to Flying Machines or Aërostats.

2353. January 30th. E. LUCAS. Improvements in or Relating to Aëronautical Machines.

2434. January 31st. F. A. BARTON. Improvements in Aërial Machines.

2454. January 31st. E. H. JONES. Improvements in or pertaining to Aëroplanes and the like.

2455. January 31st. E. H. JONES. Improvements in or pertaining to fans or propellers for Airships and the like.

3479. January 31st. P. DALTON. Improvements in Aërial Machines.

2698. January 31st. E. L. SWINGLE. Improvements in Aëronautic Apparatus or Flying Machines.

FEBRUARY.

2765. February 4th. W. B. BROOKE. Improvements in Kites.

3233. February 9th. T. MEACOCK. Improvements in Aëroplanes.

3397. February 11th. T. CRAIG. Improvements in Vessels for Aërial Navigation.

3401. February 11th. F. L. MARTINEAU. Improvements in Machines or Apparatus for Navigating the Air.

3451. February 12th. P. REES. Improvements in and Relating to Flying Machines.

3466. February 12th. S. JONES. Improvements in or Relating to Aëronautical Machines.

3570. T. HARRIS. Flying Aëroplanes.

3591. E. TANI. Improvements in or Connected with Machines for Mechanical Flight.

3909. February 16th. T. G. NYBORG. Improvements in or Relating to Navigable Aërial Machines.

4016. February 18th. G. WALLACE. Improved Non-ballasted Balloon.

4033. February 18th. E. A. TASKER. Improvements in Ships for use on Water or in Air.

4043. February 18th. L. BENOIT DE LUITTE. Improvements in Flying Machines.

4057. February 18th. H. R. SANDERS. Improvements in Kites.

4215. February 20th. D. GARRY. Airship.

4216. February 20th. D. GARRY. Aëroplanes for Airships.

4230. February 20th. H. E. HUGHES. Improvements in Kites.

4245. February 21st. J. R. PORTER. Improvements in Airships and Apparatus for Propelling the same.

4315. February 21st. S. J. LAWRENCE. Improvements in Apparatus for Lifting and Propelling Airships Aëroplanes, and other Aërial Vessels.

4506. February 23rd. Sir E. F. LAW. Improvements in and Relating to Air Vessels.

4659. February 26th. S. R. HEWITT. Improvements in Aëroplanes or Aërial Machines.

4835. February 27th. E. V. HAMMOND. Improvements in Aërial Navigation.

MARCH.

4982. March 1st. E. J. BELLAMY. Improvements in Airships.

6141. March 14th. T. B. SCAMMELL. Improvements in Methods of Propelling Steamships, Aëroplanes, and other Mechanically Driven Vehicles.

6247. March 14th. T. D. MACMILLAN. Improved Propeller Kite or Aëroplane.

6285. March 15th. J. MEAD. Improvements in and Connected with Flying Machines.

6356. March 15th. J. COLLOMB. Improved Apparatus Capable of being Navigated in Air or to Travel on Land or Water.

6414. March 16th. J. R. BARRETT. Improvements in Aërial Machines.

6488. March 18th. N. R. GORDON. Improvements in Flying Machines.

6728. March 20th. R. BACHSTEIN. Improvements in the Method of and Apparatus for Photographing from Aërially Suspended and other Moving Carriers or Vehicles.

6833. March 21st. J. WEISS. Improvements Relating to the Launching or Starting of Aëroplanes and Flying Machines.

6835. March 21st. R. M. BALSTON. Improvements in or Relating to Propellers for Aërial Travelling Apparatus.

6946. March 22nd. A. P. BLIVEN. Improvements in Flying Machines.

6978. March 22nd. D. GARRY. Improvements in Lifting and Propelling Apparatus for Airships.

7019. March 23rd. C. MULLER. Structure for Floating in the Air,

7059. March 23rd. M. NIAL. Improvements in Flying Machines.